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The Douglas-Fir Beetle

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INTRODUCTION

The Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopk.) is the most destructive insect enemy of Douglas-fir throughout the range of this important timber tree in the western United States and Canada. It occurs in the Rocky Mountain region from northern Mexico into Canada, in the Pacific coast region from the north end of Vancouver Island in British Columbia south along the coast range to Santa Cruz, and along the Cascades and Sierra Nevadas to the San Joaquin River in California.

Every year this small beetle kills millions of board feet of merchantable Douglas-fir timber—one of the most valuable woods for structural timbers, plywood, and airplane stock. The resulting snags stand for years as mute evidence of its destructiveness, often for 25 years in the Rocky Mountain region and from 50 to 100 years in the fir forests along the coast. These snags not only represent a tremendous economic loss but, until they have fallen and rotted, are also a serious fire hazard.

INFESTATION CHARACTERISTICS

Infestations by the Douglas-fir beetle vary considerably in character in different parts of its range, possibly because of wide climatic differences between the regions in which it is active. In the humid Pacific coast region, west of the Cascade Mountains, the Douglas-fir beetle usually, but not always, appears to depend on some contributing cause which provokes an outbreak. Logging slash and fire-scorched or

[1] Died February 6, 1945.

windthrown trees provide the type of host material in which it prefers to breed. When an abundance of such material is available, the beetle breeds up to large numbers. When the supply of such material becomes unsuited for brood development, the beetle often attacks and kills groups of nearby healthy trees. Usually, the infestation in healthy timber lasts only a few years, but before it subsides it may do considerable damage. An estimate of trees killed by the Douglas-fir beetle in and adjacent to the Tillamook burn of 1933 in Tillamook County, Oreg., places the loss at 200,000,000 board feet during a 3-year period following this large fire.

The habit of the Douglas-fir beetle of building up populations in damaged trees and then spreading to healthy timber provides a constant threat to modern forestry practices in timber harvest. For several years after logging, there is danger of beetle attack in seed trees left on clear-cut operations and in reserve trees left on selectively logged areas.

In the more arid Rocky Mountain portion of its range, the Douglas-fir beetle is much more aggressive. There, also, outbreaks may develop following either fire or defoliation of the trees by leaf-feeding insects, but once started they subside slowly. Many of the outbreaks apparently develop in uninjured timber and sweep over large areas, killing much of the mature fir. For example, the loss in the northern Rocky Mountain region has been estimated at 125 million board feet annually and, although no estimates have been made in the central and southern Rockies, observation leads to the belief that the beetle is even more aggressive in those regions. Localized outbreaks, such as those on the Shoshone and Washakie National Forests in Wyoming, the Powell and Dixie National Forests in Utah, and the Carson National Forest in New Mexico, have continued unabated until most of the larger trees have been killed.

DEVELOPMENTAL STAGES OF THE BEETLE

The Douglas-fir beetle (fig. 1, *A*) is cylindrical and rather stout, a little smaller in diameter than a match. When it first emerges as an adult it is yellow, but as it matures it becomes brown and then black, usually with reddish-brown wing covers. The females lay eggs (fig. 1, *B*), which hatch into legless grubs, or larvae (fig. 1, *C*), white with brown heads. When mature the larvae transform into white pupae (Fig. 1, *D*), and finally emerge as adult beetles.

RECOGNITION OF INJURY

Usually the presence of the Douglas-fir beetle is not noticed until numerous trees with faded or red foliage begin to appear singly or in groups within the forest. Several months before this, however, the first indication of attack appears in the form of red boring dust lodged in the bark crevices or bark scales along the trunks of the infested trees. Wind and rain soon destroy most of this evidence, and from that time until the foliage changes color the attacked trees cannot be distinguished by external characters, except by careful examination to detect the accumulations of boring dust at their bases.

Foliage Change

Although a large proportion of infested trees may be detected through faded foliage, it is practically impossible to recognize all trees containing living broods of this insect by this method. Douglas-fir trees vary greatly with respect to the amount of time elapsing between

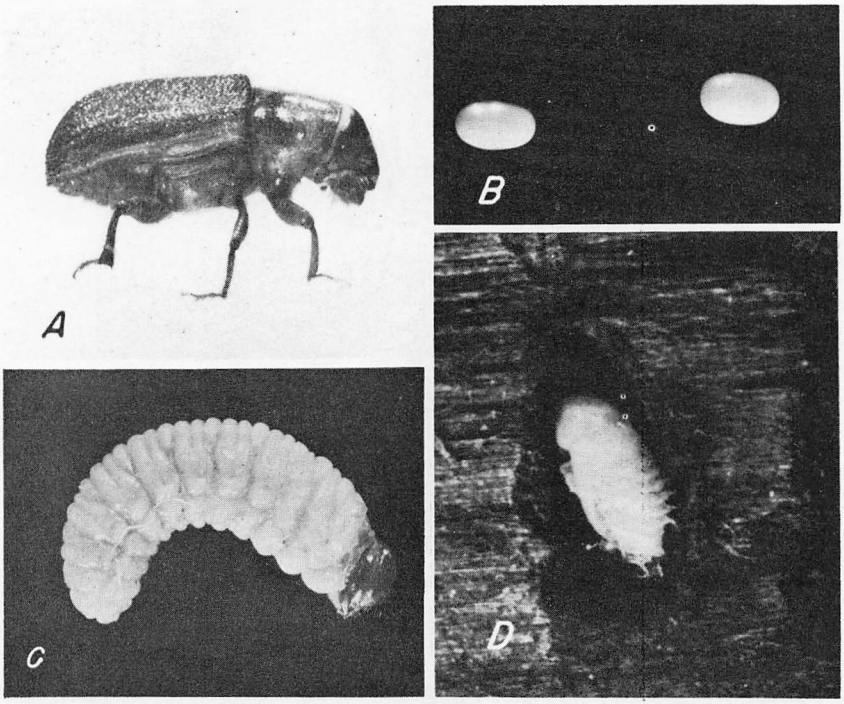

Figure 1.—Developmental stages of the Douglas-fir beetle: *A*, Adult, ×6; *B*, eggs, ×9; *C*, mature larva, ×6; *D*, pupa, ×4.

attack and foliage fade, and also in the length of time dead needles are retained on the tree. This is particularly true in the northern Rockies, where trees containing living broods may be found at any time of the year, with foliage color ranging from green through sorrel to red. Some trees even maintain red foliage for a year or more after the beetles have emerged from them.

Beetle Work

Suspicion that a tree has been attacked can usually be confirmed or allayed by removing a piece of bark with its phloem, to reveal the presence or absence of the characteristic beetle work. If the Douglas-

fir beetle is present at the base of the tree, the numerous small tunnels between the bark and wood form a typical pattern (fig. 2), which is

FIGURE 2.—Work of the Douglas-fir beetle in the inner bark of Douglas-fir, showing vertical egg galleries and fan-shaped groups of larval mines. (One-third natural size.)

readily recognizable. The egg galleries are about one-fourth inch wide and extend longitudinally up the tree from 3 to 30 inches from the point where the parent beetles enter through the bark. They are more or less parallel to the grain of the wood and most of them are packed solid with borings (fig. 3). On alternate sides of and at right angles to the egg galleries are smaller irregular lateral larval tunnels, which collectively form fan-shaped patterns, one above the other, on the inner surface of the bark. Sometimes, however, the beetles attack a tree in such numbers that they are crowded for space and the typical pattern is lost because of the excessive tunneling.

Frequently the basal portion of the tree for 15 to 30 feet is not attacked, or, if infested, may not be attacked until several months, or even a year, after the higher portions have been killed. Basal attacks are often unsuccessful because of excessive moisture beneath the bark, and when this is the case incomplete galleries similar to those shown in figure 4 will be found. Sometimes other beetles entirely fill in the bark area at the base of the tree, making work patterns

such as those shown in figures 5 and 6. Although usually classed as secondary, the flatheaded fir borer (*Melanophila drummondi* (Kby.))

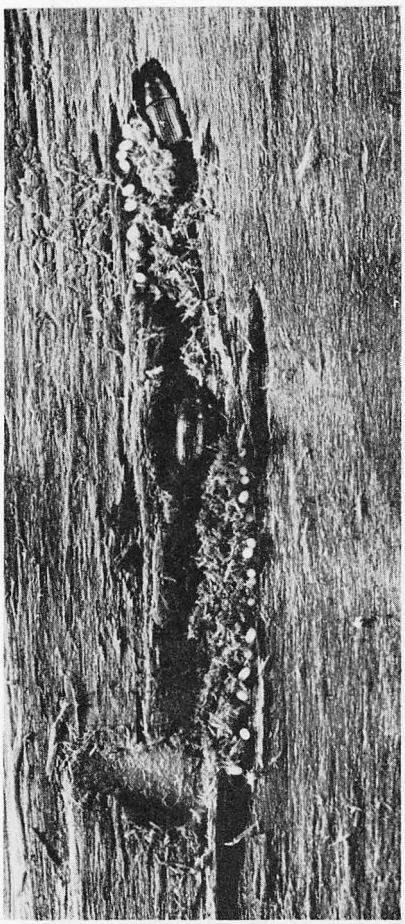

FIGURE 3.—Douglas-fir beetle eggs in groups on alternate sides of egg gallery in inner bark. Female beetle above, male below. (×1½.)

FIGURE 4.—Inner-bark surface of Douglas-fir, showing evidence of four unsuccessful Douglas-fir beetle attacks such as are frequently found at the base of trees killed by this insect. (One-half natural size.)

becomes a primary pest at times, especially in the southern part of the Douglas-fir range, where the Douglas-fir beetle is rare.

The observer must be certain that he is viewing the work of the Douglas-fir beetle. The beetle is found only in Douglas-fir and in fallen or injured western larch (*Larix occidentalis* Nutt.). Very rarely is standing larch or bigcone spruce (*Pseudotsuga macrocarpa* (Torr.) Mayr.) attacked. Other species of *Dendroctonus* make a nearly smiliar pattern in pines and spruces, but these do not attack Douglas-fir. A number of smaller bark beetles mine the upper bole and larger branches of Douglas-fir trees, but the Douglas-fir beetle rarely attacks these portions of the tree; besides, the mines of the smaller bark beetles (fig. 7) are so much smaller and usually so different in pattern that they can be separated readily.

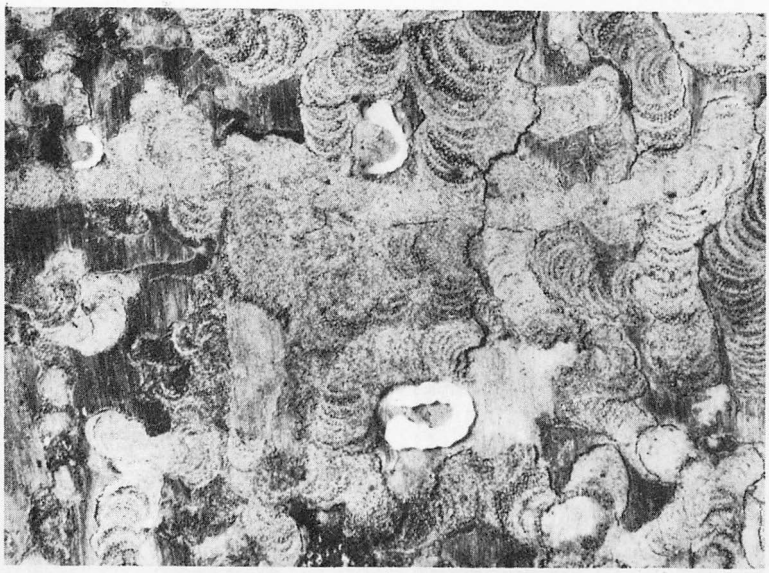

FIGURE 5.—Work and larvae of the flatheaded fir borer. (Natural size.)

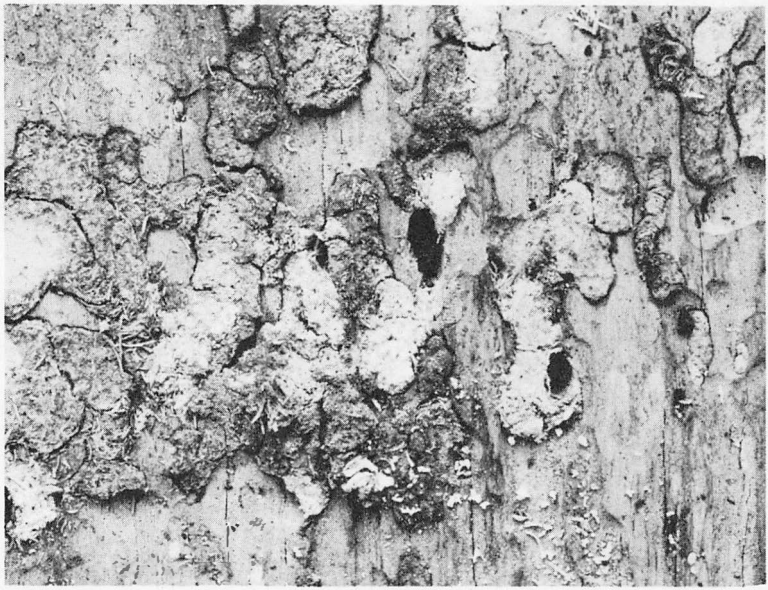

FIGURE 6.—Work of the black spruce borer, often found near the base of trees infested with the Douglas-fir beetle. (Natural size.)

HOW THE BEETLE KILLS TREES

Douglas-fir beetles emerge from the trees or logs in which they have developed and fly to uninfested ones. Upon arrival at the fresh host

material, each female, followed by a male, bores directly through the bark to the wood surface and then excavates the unbranched longitudinal egg gallery up the tree in the inner bark, grooving the wood slightly. The beetles bring with them the spores of a blue-stain fungus, *Ceratostomella pseudotsugae* Rumbold. The fungus develops in the conducting tissues of the tree, blocking the transpiration stream and thus assisting the beetles in girdling the tree, which dies in a few weeks. This blue stain can girdle and kill the tree, even though the attacking beetles fail to develop successful broods. Apparently the beetles are the only natural means of inoculating trees with the fungus.

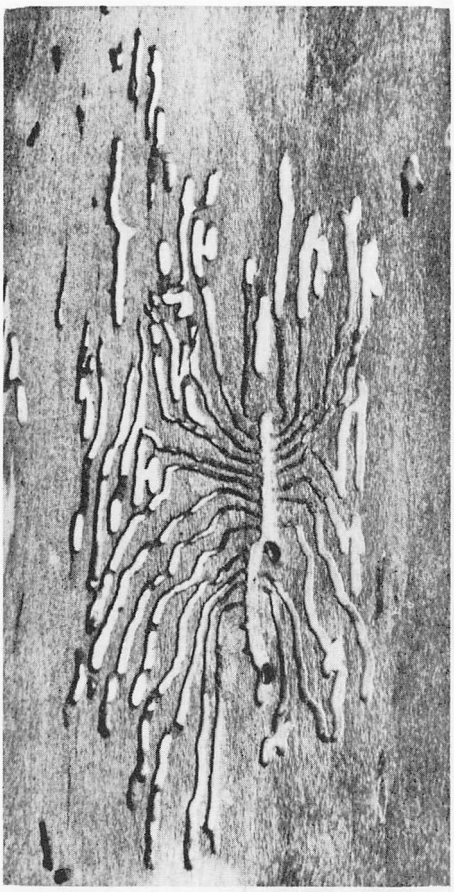

FIGURE 7.—Egg gallery and larval mines of the Douglas-fir Hylesinus, found in tops and branches of Douglas-fir.

The female beetles lay their eggs in elongate groups on alternate sides of the egg gallery (fig. 3). In about 15 days the eggs hatch into larvae, which mine between the bark and wood, more or less at right angles to the egg gallery, and widen their tunnels as they grow. After about 65 days, when the larvae have become full grown, they excavate shallow pits between the bark and wood, or cells within the bark, where they pupate. The pupae remain quiet for a week or longer before transforming into new adult beetles.

SEASONAL ACTIVITY OF THE BEETLE

Early in the spring, before insect activity begins, the Douglas-fir trees infested with the Douglas-fir beetle can be grouped in two classes, depending on the overwintering stages found beneath the bark (fig. 8). Most of these infested trees contain newly developed adults, but about one-third contain full-grown larvae and their parents, or old adult beetles. With the advent of developmental temperatures in the spring, both the old and new adults emerge and attack other trees. After excavating egg galleries and laying eggs, the old adults die,

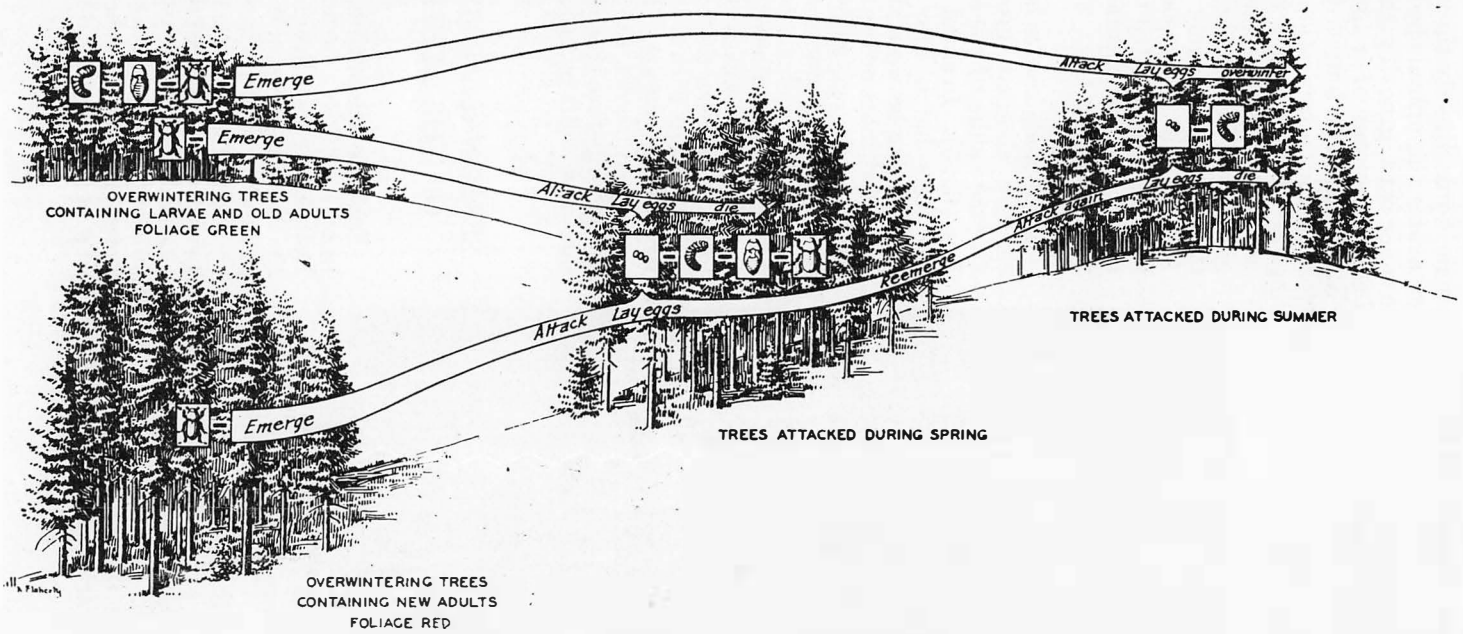

FIGURE 8.—Seasonal activity of the Douglas-fir beetle.

but the new adults re-emerge and attack other green trees and logs during the summer. After this second attack they also die.

In the meantime, the over-wintering larvae develop into new adults, which emerge and attack other trees during the summer coincident with the re-emerged or old adults from the spring attacks. Usually these young adults do not re-emerge until the following spring, but pass the winter in a semidormant condition beneath the bark of the summer-attacked trees.

Thus, the two attack periods during each season provide the reason for the two classes of overwintering trees. The broods resulting from the spring attacks develop to the new adult stage by fall; some may emerge if warm fall weather prevails, but most of them pass the winter in these trees. The broods in the summer-attacked trees reach the full grown larval stage by winter and overwinter in this immature stage, along with their parents.

Climate, however, influences Douglas-fir beetle activity, so that time of attack and the period of brood development vary throughout its range. The generalized seasonal activity described here applies specifically to northern Idaho and northeastern Washington, but indications are that it does not vary greatly throughout Washington, Oregon, Idaho, and Montana.

CONTROL

Natural Control Factors

Frequently the first question that arises in connection with control is: What can be accomplished by using parasitic and predaceous enemies to destroy the Douglas-fir beetle? It is true that, in addition to birds and bacterial and fungus diseases, a number of insects prey on the Douglas-fir beetle. Two beetles, *Enoclerus sphegeus* (F.) and *Thanasimus dubius* (F.); two flies, *Medetera aldrichii* Wheeler and *Lonchaea corticis* Taylor; and three wasplike insects, *Coeloides brunneri* Vier., *Cecidostiba dendroctoni* Ashm., and *Pachyceras eccoptogastri* Ratz., at times effect a high degree of control in nature. However, their numbers are governed by a complex set of natural conditions beyond the control of man; therefore it is impractical at the present time to increase the effectiveness of these beneficial insects, either by breeding them artificially or by fostering their development in nature.

Artificial Control

Douglas-fir beetle control must depend, therefore, on artificial methods. The only effective means yet discovered is to destroy the beetles with fire. If the infested trees are small, the best procedure is to fell the trees, cut them into logs, and pile the unpeeled logs in convenient-sized decks for burning. If possible, all logs in any one deck should be of nearly the same length and the lopped branches and top of the tree should be piled on top of the deck. This practice insures

a good burn, cleans up the debris, and precludes the danger of leaving long unburned log ends from which beetles may emerge.

If the trees are too large to handle in this manner the infested bark can be peeled from the upper surface and well down on the sides of the fallen tree and piled along the trunk with sufficient dry sticks and limbs to facilitate burning. Caution must be observed in using this form of Douglas-fir beetle control to avoid scorching green standing trees nearby. An abundance of scorched trees defeats the purpose of the control work by providing excellent host material in which the beetles not killed during the control operation can breed up again to destructive numbers. Obviously, the control operator must be careful not to let the fire get out of hand. Control work should be done preferably during the fall or spring months, when there is a considerable amount of moisture in the woods.

When Control Is Needed

In the Douglas-fir forests of the Pacific coast, Douglas-fir beetle outbreaks are so short-lived that they frequently have passed their peak before the timber owner or manager realizes that the outbreak exists. Hence, only rarely, if ever, is control feasible in this region. Methods of preventing outbreaks, however, are helpful where they can be applied. The immediate salvage of fire-scorched and windthrown timber, as well as the prevention of fires that damage living trees, will aid greatly in preventing Douglas-fir beetle outbreaks.

In the Rocky Mountain fir forests, however, control is frequently necessary. Needless to say, sound judgment based on entomological and economic considerations must be used in determining the need for these direct measures. A small amount of loss caused by insects each year is normal, and attempts to avoid it may upset the natural balance between the beetle and its enemies, and thus precipitate a widespread outbreak. If, however, an examination shows that current losses are high and that the beetles or their developing broods are abundant in the infested trees, then artificial control may be advisable. The value of the timber being killed or threatened must warrant the cost of control when considered from commercial, protection, recreational, or esthetic standpoints. It is also imperative that control measures treat as nearly as possible 100 percent of the currently infested trees.

Application of control treatments to small areas surrounded by or contiguous to areas similarly infested is useless, because of the possibility of reinfestation. This fact necessitates the cooperation of all timber owners within the infested area.

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